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Food and water security in developing economies: impact of the pandemic and possible interventions

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Abstract

Introduction: Pandemics are unexpected and unplanned events that can have serious impact on food and water security especially in countries with weak food and water systems. **Objectives**: This article discusses factors that could affect food and water security in developing countries and provides possible solutions for mitigating food and water issues that could arise due to pandemics. **Methods**: Searches were made on Google scholar and using the keywords "food and water security in pandemic" between May and October 2020 and published articles related to developing countries were obtained and reviewed. **Results**: Factors identified include: weak 'food routes to consumers', lockdown and impaired logistics, poor consumer purchasing power, scarcity of water resources, unavailable water quality data and poor wastewater treatment works. Approaches to mitigate impact of these identified factors such as possibilities of harnessing available natural resources such as solar energy and nature-based solutions for freshwater were also discussed. **Conclusions**: Collaboration between representatives from the local communities, government, and academics/researchers would play a critical role in mitigating these impacts. The outcome of our article may also extend to those working directly with public groups, including those undertaking public engagement with environmental research, government policymakers, research managers and professional membership institutions.

Keywords: Food security, water security, pandemic, lockdown, logistics, freshwater.

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1 Introduction

The Malthusian theory stated that while the human population is growing at a geometric rate, food production is only growing at an arithmetic rate. For this reason, population growth surpasses growth in food supply and food shortages are expected to occur[1]. Economists have contended that Malthus overlooked technological advancement, which would allow human beings to keep ahead of the population curve. However, issues of food shortages persist till to date.

Food security can be defined as the physical, social and economic ability to access sufficient, safe and nutritious food [2]. In the developed regions of the world, the population of undernourished people does not exceed an average of 5% of the population while in developing regions, this exceeds 13%. In particular, African countries have food insecurity reaching 20% and in Asia, this figure is 13% [3]. The main causes of hunger and malnutrition are natural cataclysms, armed conflicts, population growth, and poverty [3]. Thus, the food systems are under pressure from non-climate stressors (e.g. population and income growth, demand for animal-sourced products), and by climate change. These two stressors impact the four pillars of food security (i.e., availability, access, utilization, and stability) [4].

A pandemic could also be a source of food insecurity. However, it is not usually discussed in the scientific literature due to its rare frequency of occurrence. While natural disasters, global warming and other unplanned events like wars may cause food insecurity, their effects are usually localized, unlike a pandemic which creates global food insecurity. In particular, developing countries are already affected by water shortage and limited access for basic domestic uses and, this limited access is exacerbated in a pandemic [5]. For example, the lack of sufficient water supply and the re-diversion of limited quantity needed in agricultural use for sanitary and hygiene purposes could affect food production. Therefore, in a pandemic, water insecurity posed by limited access, insufficient, clean, quality water presents unique problems to food and health security of farmers. In the Latin American countries such as Bolivia, Colombia and Mexico, Utility companies have been encouraged to strengthen their quality monitoring in order to secure water quantity and quality[5,6] as part of the strategies to mitigate losses in pandemic. Also countries such as Brazil, Bolivia, Colombia, Honduras, Jamaica, Paraguay and Peru have taken measures such as suspension of service disconnections to ensure people have access to water supply [5, 6].

In this report, we aim to discuss the factors that influence food and water security in a pandemic, and to propose strategies to mitigate both food and water security in developing countries.

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2 Methods

A search on Google Scholar as of May 12 2020 returned 3,950,000 results for 'food security' and 61,300 results for 'food security in pandemic'. This outcome indicates that only 1.5% of food security studies discussed something related to food security during the pandemic. Hence, there is a need to conduct more studies on food insecurity during pandemics in order to inform strategies for mitigation and to manage the loss of lives that may result following the pandemic as a result of food insecurity. For this study, searches were made on Google Scholar on 'food and water security in pandemic' between May and October 2020 and published articles related to developing countries were obtained and reviewed.

3 Factors Influencing Food Security in a Pandemic

Based on observations during the current COVID-19 pandemic, three major factors that affect food security have emerged and they are: weak 'food routes to consumers'; lockdown and impaired logistics; and poor consumer purchasing powers.

3.1 Weak 'food routes to consumers'

The three main 'food routes to consumers' in developing nations are defined below:

1. From farm directly to consumers;
2. From farm to artisanal food processors (or neighborhood restaurants) to consumers;
3. From farm to food processing firms (or big eateries or restaurants) to consumers.

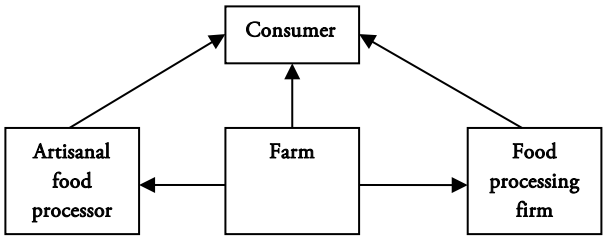

Figure 1: Food routes to consumer

Of these three routes, routes 1 and 2 pose the highest risk to food security since there is either lack of or inadequate controls with respect to food handling. Hence, these routes present increased risks for transfer of infections – which could occur as a result of coming in contact with infected foods or packaging materials. Safety issues associated with foods from routes 1 and 2 include: microbial safety (contamination of food by pathogenic organisms), chemical safety (use of non-food grade chemicals), personal hygiene (lack of proper hygiene on the part of the artisanal food processor), and environmental hygiene (poor refuse disposal, poor storage conditions, poor sanitary conditions) [7, 8].

3.2 Lockdown and impaired logistics

Lockdown is a common response during pandemics. COVID-19 lockdown measures were adopted in 184 countries based on data analysis that covered the period between 31st December 2019 and 4th May 2020 [9]. During the Spanish flu pandemic of 1918, lockdown also happened [10]. These lockdowns usually lead to a slowing down or total stoppage of activities within the food chain. Farms, food processing companies, eateries, and markets are either totally or partially shut leading to high food wastage within the food chain and poor access to food. Ebola crises in Africa led to a 12% decrease in food production as many farmers were unable to cultivate [11]. Logistics of food product delivery is critical in guaranteeing product security. Logistics in food value chains include all activities that enable the flow of agriculture inputs, outputs, and agriculture-related services, such as transportation, warehousing, procurement, packaging and inventory management [12]. The operations of logistics' firms are negatively affected during pandemics because of lockdowns and even public unrest and protests.

3.3 Poor consumer purchasing powers

Pandemics are also characterized by poor economic outlooks and developing countries are more negatively impacted due to their fragile economies. As a result of the COVID-19 global pandemic, growth in Sub-Saharan Africa is predicted to fall to -3.3% in 2020 [13]. This poor economic outlook would definitely aggravate existing economic issues in this region - which is known to consist of nations with already fragile economies. As observed during COVID-19, unemployment rates have increased across countries. Within two months, unemployment rate in the US moved from 3% (the lowest rate in 50 years) to 14.7%. The case is usually worse in developing countries that already experience high unemployment rates in pre-pandemic periods. According to the National Bureau of Statistics, the unemployment rate as of the third quarter of 2018 in Nigeria was 23.13%. The Nigerian unemployment rate as of the second quarter of 2020 increased to 27.1% and there is no doubt that COVID-19 would have played a role in this rate increase; stories of job losses and salary cuts awash the news media. Due to the aggressive nature of pandemics which result in a high level of deaths, some families may lose their breadwinners making life difficult for the affected families. The interplay of these factors reduces the purchasing power of the consumers who then find it difficult to purchase the foods required for survival – which is also not helped by high cost of foods during the pandemic period. For example in Nigeria, (according to National Bureau of Statistics) as of April 2020, the average price of 1kg (2.205 lb) of rice (imported high quality sold loose) increased year-on-year by 31.97% and month-on-month by 7.56%.

4 Factors Influencing Water Security in a Pandemic

4.1 Scarcity of resource

Globally, freshwater resources are limited resources as they make up less than 2% of the water cycle on earth. Furthermore, with increasing human population, about 5.7 billion people are projected to live in in potentially water-scarce areas for one month per year by 2050 (UN-Water, 2019). Urban water transfers from rural areas have been shown to reduce soil biodiversity needed for agricultural processes. Increasingly, urban water demand increases pressure on public supplies leading to losses of riparian vegetation and fish species [14]. According to a 2015 report by the World Health Organization, more than 40% of the scarcity is found in Africa implying additional stress on agricultural productivity. Due to this form of water scarcity diverting water from agricultural areas for use in urban locations will affect food production, and implies that cities do not have adequate supplies to face pandemics[15]. This also implies that scarce water resources are likely going to be a major source of conflict and wars and thus, food insecurity. While some developed countries such as the United Kingdom [16] have found a way to manage water shortage through water conservation, some developing nations have found a way to manage water shortage through community-based processes as seen in Angola [17] and Indonesia [18]. A community-based approach to water management will be more effective in these countries when there is sufficient and available data as found in most developed countries.. Also, with intense agricultural expansion, evapotranspiration increases [19] and freshwater runoff and aquifer recharge decrease worldwide. For these reasons, agricultural practices will continuously degrade the quality and ecological status of the freshwater ecosystems, with status improvements remaining slow [20]. In developed countries, this is a major challenge especially in the application and implementation of environmental regulation to farming agricultural practices which is not so available

4.2 Unavailable water quantity and quality information

While some parts of Latin America, Indonesia, Asia, Europe [6, 18,21,22] have reported the status of water supply and quality during the pandemic, there had been limited reports from the African continent. The response of the lockdown to the consequences of the outbreak containment measures on freshwater quality has barely been published in the mainstream media and scientific platforms. While the lack of substantial and evidential information from the continent presents a further challenge to mitigation on supplies, access and quality, the present pandemic situation provides a chance to rethink water use supply and sanitation (aligns with the United Nations' Sustainable Development Goal [6]). The World Resources Institute showed possible ways by which countries can use the challenge of COVID-19 as an opportunity to invest in water management and supplies. Water shortages, intermittent water supply, poor infrastructural networks needed to provide high-quality drinking water have been shown to be major problems in most urban slums of the world [23].

4.3 Quality of wastewater treatment work, inequality and access

Most wastewater treatment works in Europe and other developed countries invest in the treatment of sewage before effluent discharge to rivers. Furthermore, some of the variables treated in the water and waste water are measured against standards used across Europe [24]. Gormley *et al.* [22] reported the need to safeguard our wastewater plumbing system following the example from SARS-CoV-2. Hence, nations with poor quality wastewater works expose their citizenry to risk of infection through their water chain. It also reveals a need to invest in water quality monitoring and data acquisition for periods such as the pandemic.

From these reports, COVID-19 has further revealed the challenges of inequality in the access to available clean water. There are gaps in available water infrastructure, treatment and provision between the haves and the have nots, between developed and underdeveloped, between and within countries. For example, in Nigeria, the Federal Ministry of Water Resources partners with the Non-Governmental Organization Water Aid to highlight the importance of hygiene behaviors as crucial to controlling and preventing the spread of COVID-19 [25]. Although awareness creation is required in the present condition, the main problem of water management, maintenance, sanitation, monitoring and assessment is yet to be addressed i.e. the quality of the water infrastructure and treatment of municipal supplies.

While the have nots will suffer more from lack of/shortage of clean water, increased diseases such as diarrhea, lack of sanitation, poor health and vitality, high death rates [26], the challenge of COVID-19 to farmers, hence food insecurity in these conditions are heightened. The challenge has deepened existing inequalities between and within countries. At present, there are no written reports from the Federal Ministry of Environment, Nigeria to assess improvements/deterioration in freshwater bodies based on the COVID-19 lockdown. Therefore, the implementation of the United Nations Sustainable Development Goals [27] for reducing inequalities and [28] for clean water and sanitation has never been more needed than this time. This is a new call for water researchers and scientists and water managers to engage and contribute to policies that will change the status quo

5 Mitigating the Impact of Pandemics on Food and Water Security

Since the food supply chain is severely affected by pandemics measures should be taken to reduce wastage right from the farm and other parts of the water supply chain. An approach to addressing this is to deploy affordable and simple post-harvest technologies and food processing techniques to convert farm produce that is harvested into stable products immediately on the farm. This would enable these food products to keep longer, thus reducing food wastage. This approach would also help guarantee food stability as the reduction in postharvest losses, could help reduce price volatility and make food available all year round. Reducing of water activity of these farm produce right on the farm

is a reliable way of producing products that can keep for longer periods. Reduction in water activity can be achieved using simple techniques like dehydration or use of additives like salt and sugar. However, in pandemics, additives like salt and sugar may not be readily available and may also be more expensive to be used in the farm during pandemics. A very promising technology to use in the farm in pandemics is dehydration because solar energy can be harnessed to achieve this. Dehydration is one of the easiest methods to preserve agricultural produce; it is an important complementary treatment and food preservation technique, since it presents some benefits such as reducing the damage to the flavor and color of foods [29]. In the tropics it is sunny almost all year round hence; the power of solar technology can be easily harnessed. In developing countries, it is observed that producers of local foods dry their food products by spreading them out in the sun to dry over several days sometimes in the backyard or beside motorways. Drying this way could lead to food contamination which is not desirable. To better harness solar power in pandemics, the government of developing countries can begin to invest more in technology for solar cabinets. Solar cabinets have several advantages in that drying can be faster, products are enclosed thus preventing contamination, products can be left in the solar cabinets till they dry (instead of the usual practice of bringing out the products in the morning to dry and then packing them in the evening which is a daily practice associated with traditional sun- drying). Solar-dried vegetables have been shown to have higher nutritive value, good appearance, good taste, and better hygiene than open sun–dried vegetables [30]. With the use of solar technology for drying highly perishable products like tomatoes, peppers, and cassava can be preserved till logistics can be provided to move them to where they are needed during pandemics. Solar technology can also be harnessed during the pandemic to power devices needed to meet water requirements on the farm.

If foods are going to be processed on farms, then, access to suitable water for processing is important in pandemics. It has been reported that water will be a major constraint for agriculture especially in Sub Saharan Africa where rainfall is generally low and the population is increasing rapidly [31] Investments in irrigation, better storage facilities, or higher food imports can help improve stability [32]. For example, Nature-Based Solutions (NBS) have been shown to be a cost-effective, efficient, and adaptable method for improving water storage and availability and, potentially reducing competition between users [33,34]. By encouraging green infrastructures such as practiced in Dar es Salaam and Copenhagen [35], citizens could be encouraged to have rain gardens and wetlands in both urban and rural areas. This practice will improve water quality and storage thereby, protecting poorer communities from water shortage and diseases such as experienced in a pandemic. While untreated water and wastewater contain high levels of fecal coliforms, *Escherichia coli, Klebsiella spp.*, *Salmonella spp.* and *Listeria spp* and other contaminants as noticed in the irrigation waters at Bangladesh [36], the outbreak of zoonotic diseases such as COVID-19 [37], could increase pollution concentration. Most developing countries will struggle with access and availability of clean water, which is worsened in a pandemic. To ensure good access and availability to water, increased awareness of health and sanitation is necessary. Also, by combining green and gray infrastructure [38], farming practices could be maintained sustainably. Other possible intervention includes the collaboration between partnership groups including representatives from the local communities, government, members of the water resources department and academics/researchers, technicians. These institutions could be effective for sustainable good water governance. Furthermore, the inclusion of citizens in the management of water resources has been shown to improve conservation science, natural resource management, environmental protection and an effective educational tool for capacity building [39, 40] and PAMSIMAS in Indonesia [17]. Wastewater treatment is a major sustainability challenge in developing economies [41]. Investment in water and wastewater treatment and data collection and storage is paramount especially in a pandemic for effective forecasting of water availability and quality.

Fresh foods may also be similarly exposed to infectious organisms like pandemic-causing viruses before being frozen and in this case, transmission may happen [42]. Hence, players involved in the food distribution chain especially those involved in these routes to consumers; 'farm directly to consumers' and 'farm to artisanal food processors (or neighborhood restaurants) to consumers', should be properly trained in appropriate food handling practices so as to prevent or reduce transmission of infection during pandemics. The need to focus on these two routes to consumers stems from the fact that workers in these routes are not usually aware of appropriate food handling practices – and they form the major routes for getting food to consumers in most developing nations [43]. The role of transportation and logistics is important in increasing food security [44]. In low to middle-income countries, public investment in transport infrastructure can help reduce the food spoilage [2]. Diversified transport systems can help in ensuring accessibility to food during pandemics. Rather than relying on land transportation only (as mostly done in developing countries), use of other modes of transportation like water and rail can enhance the availability and access of adequate and nutritious foods. Diversification of transportation modes is important such that if one mode of transportation is affected during a pandemic then, other modes of transportation are available and can be used to get foods across to the consumers. Solar power can also be deployed to ensure safe transport of foods during pandemics. For example, solar-powered mobile refrigeration units may help address the cold-storage challenge in remote places, where access to energy is unreliable or too expensive, and the reliance on fossil fuels to generate needed electricity [44].

Due to poor economic situations during pandemics, governments in developing countries should make efforts to make food available and accessible to citizens especially the most vulnerable groups. Many countries use food subsidies, cash transfers and income-generating strategies to target low-income households [2]. While this approach needs to be embraced by governments of developing economies and, especially during pandemics, food can also be provided for free to the most vulnerable groups– or at a very affordable price for the less vulnerable groups. A challenge with developing countries in achieving effective distribution of

foods is the lack of a verifiable database for the countries' citizenry which makes it difficult to identify and locate the most vulnerable during pandemics. Hence, governments in developing countries need to start taking appropriate actions to get detailed and verified database of their citizens and residents to help for better management during pandemics.

Although food availability and accessibility are necessary conditions for food utilization, they are not sufficient conditions to reduce malnutrition [45]. Thus, ensuring people have balanced diets is very key during pandemics as this could help improve their immunity against infections. Since lockdown could impede movement during pandemics, a veritable tool to improve food utilization would be through the use of media such as radio, television and internet. Government can sponsor programs, through these media, that teach the people about nutrition, adequate selection of meals and proper methods of preparing meals. Mobile apps may offer a potentially effective approach to supporting healthier food purchasing behavior. Communication through mobile phones also presents a strategy to improve food utilization especially with the increased usage of mobile phones in rural areas [46]. It has also been reported that mobile apps may offer a potentially effective approach to supporting healthier food purchasing behavior [47].

6 Conclusion

Food and water security is a global challenge especially in developing countries and this issue can be exacerbated in a pandemic. In this report, we identified and discussed the challenges to food and water security in developing countries especially during pandemics and the strategies to mitigate these challenges. The issues identified are: weak 'food routes to consumer', lockdown and impaired logistics, poor consumer purchasing powers, water scarcity, unavailability of water quality and quantity information and poor quality of wastewater treatment works. One of the strategies proposed to address these challenges is deployment of affordable and simple post-harvest technologies and food processing techniques to convert farm produce that is harvested into stable products immediately on the farm. A promising technology that could be used to achieve this is the application of solar energy especially for countries in the Tropics. Other strategies that could be deployed to mitigate these challenges include: providing access to suitable water for processing food on farms, increasing public awareness on sanitation, training of artisanal food processors in appropriate food handling techniques, diversification of transport systems to ensure food accessibility, utilization of food subsidies, cash transfers and income-generating strategies to target low-income households, development of detailed and verified database of citizens and residents to help for better management during pandemics, and deployment of nutritional communication through mobile phones and media such as radio, television and internet. The issues raised in this report will contribute to resources needed by researchers, Government and Non-Government organizations, and partnership groups to agree on ways forward to reducing the impact of environmental resources on individuals, communities and to the developing countries at large.

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